

# An Economic Approach to Environmental Sustainability

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## Abstract

There is a history of antagonism between industrial interests and environmental protection efforts. Core business values have often excluded environmental responsibility, and environmental regulations have often discouraged industrial progress. Many companies, however, are turning this around and creating a new phase of industrial processes that are compatible with natural processes. By designing industrial and manufacturing systems for environmental sustainability businesses have realized fewer expenses and liabilities with greater revenue. Through elimination of waste, companies are saving money by increasing material use efficiency and decreasing waste disposal costs. Utilizing recycled or renewable materials indicates lower material costs and less extraction of raw materials, leading to fewer dollars spent on remediation. Employing less toxic materials can provide the same performance with less cost and less risk. This new terrain in systems design offers opportunities for businesses to achieve a competitive advantage and exceed environmental regulations while practicing environmentally sustainable methods.

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There is a history of antagonism between industrial interests and environmental protection efforts. Core business values have often excluded environmental responsibility, and environmental regulations have often discouraged industrial progress. There is a shift happening on both sides, however, that is spurring cooperative efforts to promote both economic viability and environmental sustainability. Many companies are working to create a new phase of industrial processes that are compatible with natural processes. Government and non-profit agencies are also working with industry to assist their efforts in environmental responsibility and pollution reduction.

Through environmentally sustainable industrial and manufacturing system design, businesses have realized fewer expenses and liabilities with greater revenue. By eliminating waste companies are saving money by increasing material-use efficiency and decreasing waste disposal costs. Utilizing recycled or renewable materials indicates lower material costs and less extraction of raw materials, leading to fewer dollars spent on remediation. Employing less toxic materials can provide the same performance with less cost and less risk. This new terrain in systems design offers opportunities for businesses to achieve a competitive advantage and exceed environmental regulations while practicing environmentally sustainable methods. Many industries that consume natural resources and produce waste and pollution can operate more sustainably and realize more profit by doing so.

## Processes and Environmental Management Systems

### Design for Environment

Many companies, and some industries, have used various approaches to achieve more sustainable production or operations processes. One process utilized extensively in the engineering field is Design for Environment (DfE). DfE is an established modern approach to industrial product design that focuses on the future. The processes and products that are being designed today by engineers and executives will greatly contribute to the level of sustainability we can achieve tomorrow. DfE focuses on “evaluating the structural role of the firm in the life cycles of the products, processes, and materials with which it deals, then using that knowledge to create environmental preferable practices based on the firm’s position in the web of commerce” (Graedel et al.1998).

Some of the goals and principles of DfE are:

- No waste
  - Every molecule that enters a process is used
  - Every erg of energy is used
- Minimize use of materials and energy
- Choose abundant, non-toxic materials
- Use recycled materials as much as possible
- Design products to be recycled or reused
- Design facilities for compatibility with local habitat and species
- Minimize packaging

DfE focuses on reducing the volume and toxicity of waste and designing for energy efficiency. Reducing material and energy consumption saves both manufacturers and customers money. There are many examples where DfE has eliminated or greatly reduced waste from industrial systems and products.

One of the principles of DfE is recycling or closing the loop. The best option is to integrate the materials back into the same life cycle. The second best is to create a market for recycling. One landfill job can stimulate 10 jobs in recycling. Recycling is greatly advantageous to preserving natural resources. Recycling one ton of paper saves 7000 gallons of water. 100 gallons of new oil can be recycled to create 80 gallons of recycled oil.

When engineers are designing or redesigning processes to incorporate DfE they ask the following questions:

- Can material be recycled with current technology?
- Can it be easily separated out?
- Can components be recycled together?
- How long does the product need to last?
- Are the materials raw or recycled?
- How much energy is used for production of each type of material?
- What is the cost?
- Can hazardous substances be designed out?

Asking these questions helps them to create a product that looks at material performance, cost, and environmental impact, and is highly recyclable. Currently 70-90% of metals are recycled, while only 3-9% of plastics are recycled. There is not much research going on in plastic recycling and it is a hindrance to DfE. There is some interest growing, however, in bio-based plastics vs. petroleum-based plastics. Bio-based plastics create fewer pollutants and decrease dependence on oil.

## **Industrial Ecology**

Industrial ecology is very similar to DfE. The difference is that attempts to mimic natural systems. It provides a framework to restore ecosystems through the design, redesign, and management of industrial systems by taking advantage of the cyclic patterns of materials and energy flow found in natural ecosystems. Unlike the traditional model of industrial activity, the flow and stock of materials and energy is optimized so that emphasis is placed on efficiency, waste recovery and exchange, and the minimization of adverse environmental impact.

## **Case Study**

Fitz's Auto Parts is located in Woodinville, Washington. Fitz's has always seen itself as an auto recycler, and never as a junkyard. This simple distinction has guided their process development and business decisions since 1931. Fitz's original owners believed that to maintain the value of their real estate they needed to keep it clean and unpolluted. This is quite different from many "junkyard" owners who find it easiest to simply put cars in a large lot and let them sit until a part is needed off of them. In this situation the toxic fluids in the vehicle often leak onto the ground and can leech into the ground water. Fitz's has avoided this problem by removing all fluids from the vehicle before placing it on a lot and by not allowing the vehicles to sit for more than a week.

## **Process**

The process begins with the arrival of the vehicle. Each vehicle is first entered into the inventory management system and the "Vehicle Identification Number" (VIN) and scrap title are verified. This is to insure against recycling stolen vehicles. The fluids are then drained and captured and the vehicle is then disassembled. All salvageable parts are bar-coded and placed in a warehouse. Parts that are unusable are distributed to recyclers. Very little of the vehicle ends up in the dumpster. The business recycles 200 cars per month and produces one dumpster of trash.

Waste products such as mercury are sent in a sealed container to Safety Kleen, a national recycler of hazardous waste. The waste oil is also sent to Safety Kleen. Fitz's used to recycle antifreeze themselves but found it more efficient to sell it to a local specialized recycler. The gas and diesel are all reused either on site or in employee's vehicles.

## Changes

While Fitz's has always practiced environmentally sustainable methods, there have been improvements and changes over the years. Today a lot less stuff goes to the landfill than it did in 1931. As markets become available, more components can be sold to recyclers. Metal scrap for instance used to end up in the landfill but today most metal is recycled and resold (there is now a strong market for it). Wire also used to go to the landfill, but is now sent to wire recyclers who strip the plastic off and recycle the wire. The plastic usually ends up in the landfill, which dismays Fitz's general manager Angus Harris.

The market for plastic recycling is much weaker than for metals. Harris says that some vehicles have over 100 different plastics. He is excited that European legislation is addressing end-of-life product issues and is working to reduce the number of different types of plastics used in vehicles. He believes that if you make a car smart, you can recycle most of it. Harris said that over the years manufacturers have started to build cars that are more recyclable.

Another change that Fitz's made was to consolidate their operations. At one time they had five different locations, each specializing in a particular make of vehicle. Today, they are down to two, both within 1500 feet of each other. Harris says this allows them to utilize their space more wisely and to reduce traveling by employees and customers.

Fitz's has remained very profitable through the years and has not seen any decline in business despite the economic turmoil of the past three years. Some other auto recyclers and wrecking yards have not fared as well. Harris knows of two that were shut down in the past five years due to hazardous material contamination. Gerry's, which used to be near Fitz's, is now classified as a superfund site.

Fitz's is now called GreenLeaf Auto. They were bought out in 2000 by a national chain with 30 outlets. The operation procedures have basically stayed the same. GreenLeaf was founded in 1999. Part of their mission is to offer customers the opportunity to increase profitability by decreasing costs. Another large part of their mission is to contribute to environmental sustainability; using recycled automotive parts dramatically lessens dumping and landfill accumulation. They work continually to insure that no hazardous materials are released into the air, soil or water as a result of their operations, and every effort is made to minimize environmental impact. From their viewpoint they are creating a greener future for the environment, as well as for their company's bottom line.

## Success in Large Industry

The 3M Corporation provides another interesting case study. 3M is similar to Fitz's in that they strive to be environmentally and socially responsible, and that they practice sustainable methods within their daily processes. They are different, however, in how their practices evolved.

In 1974 3M discovered that one of the chemicals in their Scotchgard products, that it was solely responsible for producing, was found in mother's milk in many parts of the world. This alarmed them and they promptly discontinued use of that chemical. In addition they added to their corporate values the need to respect their social and physical environment.

In 1975 they began the Pollution Prevention Pays program. Since then they have originated almost 5,000 projects that have focused on product reformulation, process modification, equipment redesign, and recovery of raw materials. These projects have eliminated more than 1.2 billion pounds of pollution to the air, water, and land and have significantly cut pollution per unit of production.

Their environmental progress from 1990-2001 has seen the following:

- 91 percent reduction in volatile organic air emissions
- 84 percent reduction in manufacturing releases to water
- 12 percent reduction in solid waste
- 35 percent reduction in our rate of waste generation
- 88 percent reduction in U.S. EPA Toxic Release Inventory (TRI) releases

3M is continuing and expanding its environmental management plan by adding in Life Cycle Management (LCM) to put additional focus on both processes and products throughout their entire life cycles, from manufacturing through customer use and disposal. In 2001, 3M adopted a new Life Cycle Management Policy requiring all business units to conduct LCM reviews for all new products and to start a process of LCM reviews on existing products.

3M continues as well to be economically prosperous. They have seen growth in sales almost continuously since the 1970s. The company's financials for last year were:

2002 Sales (mil.): \$16,332

1-Yr. Sales Growth: 1.6%

2002 Net Inc. (mil.): \$1,974

1-Yr. Net Inc. Growth: 38.0%

2002 Employees: 68,774

1-Yr. Employee Growth: 4.0%

3M is just one of many companies that are incorporating DfE and life cycle analysis. Others include Xerox, Dell, McDonalds, Starbucks, Patagonia, Electrolux, OKI Semiconductor, Healthy Planet Foods, Busby and Associates, Matsushita, Honda, Mitsubishi and Matsushita Electronics. The list is long and growing. Matsushita, a subsidiary of Panasonic based in Japan, has created a Home Appliance Recycling System focusing on TVs, air conditioners, refrigerators, and washing machines. They are successfully recycling at least 50% of the products returned. They opened the Matsushita Eco Technology Center in April 2001 to research and develop ways to use scrapped materials in new products and to develop highly recyclable products. Their concept is to "make new products from end-of-life products".

Xerox is also using the idea of modularity and recycling quite successfully. They lease their copiers rather than sell them. They take them back at the end of the lease, refurbish them, and send them out again with many of the same components. Dell has also been very active in computer recycling and has just started, in March of 2003, a home computer pick-up and printer recycling program. The cost to consumers is \$15 for non-Dell purchasers and free for Dell customers.

### **Key Lessons from Strategic Sustainability Leaders**

In a study done by Ekos International, 20 successful businesses were interviewed to discover what strategies they used. Following is a list of the top answers.

- Commitment and Dedication at the Highest Level.
- Integrate Environmental Department with Business Department.
- Set Goals, Take Action, Measure Progress.
- Transparency and Integrity of Environmental Data.
- Educate and Include Employees.
- Bring Suppliers Along.
- Collaborate Broadly, Use Available Resources.

### **Resources for Industry**

There are numerous agencies and organizations that are working to assist industry in becoming more environmentally sustainable. If industry is interested there are many resources available to help locally, nationally, and internationally. A few of these are highlighted below.

#### **Clean Washington Center**

Since 1991, the Clean Washington Center's focus and mission has been to develop markets, technologies, and beneficial end uses for recycled materials and to provide manufacturers and local governments with assistance in increasing the use of recycled materials. The Clean Washington Center (CWC) began as a division within the Washington State Department of Community, Trade, and Economic Development. It has now become a part of the non-profit Pacific Northwest Economic Region (PNWER). On their website they offer technical publications on recycling best practices for glass, wood, rubber, and plastics, along with project reports covering processing and manufacturing issues, product performance, and strategies for overcoming business and regulatory barriers to recycling.

#### **King County Solid Waste Division**

There are many departments within this division that are working towards environmental sustainability. One of these is the Green Building Team. They have helped to institute LEED™, a web-based tool to help owners, architects, designers, contractors, project managers or building professionals develop green buildings in King County. They have also helped

create the reuse and recycle database that has listings of recycling services in King County and beyond. Other services include the [Reusable Building Materials Exchange \(RBME\)](#) - [Sample Specifications and Waste Management Plans](#), and [Worksheets for Calculating Recycling Costs and Savings](#).

### **EnviroStars**

The EnviroStars program, started in 1995 in King County, is a recognition and incentive program for hazardous waste prevention and management. It is designed for smaller businesses that generate under 2200 pounds/month of hazardous waste. It uses positive recognition as an incentive for businesses and seeks to influence purchasing decisions by consumers through increased awareness. There are currently 458 businesses that are EnviroStar certified across 6 counties: Jefferson, King, Kitsap, Pierce, Snohomish, and Whatcom.

For businesses that generate larger quantities of hazardous waste the Department of Ecology has developed Pollution Prevention Planning resources and offers free on-site expert advice. The EPA has also developed resources for pollution prevention and has published “The Organizational Guide to Pollution Prevention” to help businesses develop processes to decrease the amount of pollution they generate.

### **The Coalition for Environmentally Responsible Economies (CERES)**

encourages corporate environmental responsibility. They encourage companies to endorse the CERES Principles and they work with endorsing companies both on meeting their commitment and on environmental reporting through the Global Reporting Initiative. When companies endorse the CERES Principles they make a commitment to environmental awareness and accountability and an ongoing process of continuous improvement. One of the benefits to companies is access to experts in the CERES network, from investors to policy analysts, energy experts, and scientists.

### **International Organization for Standardization (ISO)**

ISO 14001 is an international set of standards and guidelines that assist businesses in reducing hazardous waste and consequently results in less soil, air, and water pollution. ISO 14001 certification is required of vendors of many manufacturers.

### **Industry Canada**

Industry Canada’s Environmental Affairs Branch promotes the development and diffusion of key environmental science and technological capabilities, which enhance industrial competitiveness. As well, it promotes the growth and development of an internationally competitive environmental industry and facilitates the transfer of environmental technologies to other countries through trade and development work.

As part of these efforts, Technology Partnerships Canada, a technology investment fund, was established to help promote, among many other things, environmental technologies that contribute to the achievement of sustainable development or have significant environmental benefits. It involves projects in priority areas such as the development of sustainable alternatives, as well as pollution prevention, abatement, and remediation.

### **The Sustainability Committee of the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC)**

The APEGBC has published “Sustainability in Professional Engineering and Geoscience: A Primer” to assist industry in developing environmentally sustainable practices.

### **Other Resources**

Other resources include Environment Canada, Washington State Department of Ecology, U. S. Environmental Protection Agency, the Fraser Basin Council, and the Solid Waste Association of North America. There are many more as well all working to help industry and the environment co-exist sustainably.

### **Conclusion**

In summary, there are many processes and management systems that if utilized can help companies meet and exceed regulations, save money by increasing material efficiency, and improve public image. The greening of industry will be big business in the coming decades as companies realize that to maintain a competitive edge; they will need to design out inefficiencies in their processes, and maintain an image of environmental responsibility. Manufacturing is entering a new paradigm that involves respect for the environment we all live in and depend on. The companies that realize this are setting the trend to achieve profits while improving environmental practices.

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